VERNOV, S. N.

"Interactions of primary cosmic-ray particles of different energies with nuclei in the atmosphere," a paper submitted at the XLI International Conference on Elementary Particles, 12-18 June 1955, Pisa, Italy.

VERNOV, S. N.

2761
A STUDY OF NUCLEON INTERACTION WITH LIGHT NUCLEI AT THE ENERGY RANGE OF $10^9 \div 10^{12}$ ev. S. N. Vernov, N. L. Grigorov, G. T. Zatsepin, and A. E. [illegible]

[illegible] Physics Invest Akad Nauk [illegible]

[illegible]

Russian

Studies of various components of cosmic rays at different stratosphere levels revealed the basic characteristics of interaction processes of nucleons with light nuclei at various energies. Diagrams and tabulations are presented. 12 references. (R.V.J.)

VERNOV, S. N., GINZBURG, V. L., KURNOSOVA, L. V., ROZORIONOV, L. A., and FRADKIN, M. I

"Study of the Primary Cosmic Radiation by Using Artificial Satellites of the Earth," a paper presented at the 8th International Astronautical Congress, 6-12 Oct 1957, Barcelona.

VERNOV, S.N.

338

PHASE I BOOK EXPLOITATION

Vtoroy sovetskiy iskusstvennyy sputnik Zemli; materialy, opublikovannyye v gazete "Pravda" (The Second Soviet Artificial Earth Satellite; Material Published in "Pravda") Moscow, Izd-vo "Pravda", 1957. 47 p. 100,000 copies printed.

PURPOSE: The booklet was written to give the public information on the second artificial earth satellite.

COVERAGE: The book consists of a number of articles on the second sputnik originally published in the Moscow newspaper "Pravda". Basic information on orbit, structure, equipment, performance, and utilization of the sputniks is given. All these data have been repeatedly published elsewhere; therefore, only a few figures are arbitrarily singled out here. The total weight of the scientific apparatus, test animal, and power supply sources of the second sputnik was 508.3 kg. The initial orbital velocity was about 8,000 m per second. The second sputnik circled

Card 1/4

The Second Soviet Artificial Earth Satellite (Cont.)

the earth initially in 103.7 minutes. Its radio transmitters operated on frequencies of 40.002 and 20.005 megacycles, etc. The last article quotes admiring comments of American, British, French, and Chinese scientists, statesmen, and journalists. The book contains 8 figures.

TABLE OF CONTENTS:

The Second Soviet Artificial Earth Satellite (Cont.)

Card 3/4

The Second Soviet Artificial Earth Satellite (Cont.)

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Card 4/4

53-2-10/28

AUTHOR VERNOV, S.N., LOGACHEV, Yu.I., CHUDAKOV, A.E., SHAFER, Yu.G.

TITLE The Investigation of the Variations of Cosmic Radiation (Issledovaniye variatsiy kosmicheskogo izlucheniya. Russian)

PERIODICAL Uspekhi Fiz. Nauk, 1957, Vol 63, Nr 1b, pp 149 - 162 (U.S.S.R.)

ABSTRACT The present paper reports on the problem of the use of an artificial satellite for the study of the variations of cosmic radiation. By means of a comparatively simple apparatus consisting of a counter and ionization chamber the following phenomena can be studied: a) the variations of the primary cosmic radiation. b) the variations of the multiply charged component of the primary cosmic radiation which consists of helium nuclei and heavier atoms. c) the geomagnetic field at great distances from the earth. d) the albedo of the earth for cosmic radiation. e) the structure of currents emitted by the sun.

I. Possibilities offered by the artificial earth satellites for the investigation of the variations. The variations of the secondary cosmic radiation differ essentially from the variations of the primary radiation. It is just for that reason that the study of the variations of the primary radiation is desirable. The variations recorded at sea level are usually much smaller than the variations of primary radiation. The measurements obtained by means of rockets are very inaccurate because of the short stay of the rockets in high altitudes, but artificial earth

Card 1/4

satellites offer great possibilities in this respect. Simultaneous measurements by counters and ionization chambers make a comparison of the variation of intensity of the primary protons with the variation of the intensity of the heavier primary nuclei possible. The variations have to be determined in the various regions of the energy spectrum of cosmic radiation. This is only possible on satellites with suitably selected orbits. The measurements of the intensity above the polar regions are of special interest.

II. The various phenomena which can be studied by an apparatus fixed in the satellite. The authors here consider the case that the satellite flies over the poles and is half of the time in the earth's shadow. Further, the measurement data can be transmitted during the entire time of the satellite's existence. The experimental material thus obtained on one single day by far surpasses the hitherto existing material this field. By a comparison of the material obtained from various revolutions and on various days the variations of intensity of the cosmic radiation can be concluded. If the data for the intensity and for the ionization power of cosmic radion over the entire surface of the globe is available, interesting conclusions concerning the following phenomena may be drawn.

The Investigation of the Variations of Cosmic Radiation

1.) the alteration of intensity in time (great irregularities of intensity in connection with eruptions of the solar chromosphere, reduction of intensity during magnetic storms, the variation (one and a half hour variation)) connected with the revolution of the satellite round the earth, the variations of intensity of the heavy nuclei of primary cosmic radiation, the long-time periodic variations, the experimental verification of the conncetion between primary and secondary variations. 2.) the earthmagnetic field and the interplanetary magnetic field. 3.) the alteration of the earth's albedo for cosmic radiation. 4.) the search for electrons and photon in the primary cosmic radiation.

III. The apparatus for the study of the variations of cosmic radiation outside the earth's atmosphere can determine these variations by measuring the variations of the ionization or the variations of particles passing through a counter. The influence of a possible revolution of the satellite is pointed out, but this variation can at least partially be compensated by fixing two counters to the satellite. For the radiotechnical equipment semiconductor triodes and tiratrones with a cold cathode are used. The following elements of the apparatus are discussed more in details: a) the counters of the charged particles, and b) the

53-11-20/18

The Investigation of the Variations of Cosmic Radiation counting method by means of semicondcutor triodes. (5 illustrations)

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Card 4/4.

VERNOV, S.N.

53-1a-9/18

AUTHOR VERNOV, S.N., GINZBURG, V.L., KURNOSOVA, L.V., RAZORENOV, L.A., FRADKIN, M.I.

TITLE The Investigation of the Composition of Primary Cosmic Radiation (Issledovaniye sostava pervichnogo kosmicheskogo izlucheniya. Russian)

PERIODICAL Uspekhi Fiz. Nauk, 1957, Vol 63, Nr 1a, pp 131 - Nr 1b, pp 148 (U.S.S.R.)

ABSTRACT According to the data available at present, cosmic radiation consists of protons, α-particles and, to a far less extent, of heavy nuclei. The distribution of the nuclei with $Z > 2$ has as yet not been investigated sufficiently well and also other problems are still to be solved. Rockets are not suited for such measurements because their time of flight outside the atmosphere is too short. By means of artificial earth satellites, however, the necessary statistical material for the investigation of rarely occurring heavy nuclei can be obtained. One of the most important problems concerns the numerical ratio between the currents of the light nuclei Li, Be, B and the nuclei C, N, O, F. By experimental determination of this ratio the various theories concerning the creation of cosmic radiation can be confirmed or rejected, If the particles of the cosmic radiation in the clouds of the supernovae are accelerated, a value $\geq 0{,}1$ is obtained for the ratio (Li, Be, B) / (C, N, O, F). In the case of this theory the ratio can also be somewhat higher, but never lower than 0,1. The data at present obtained for this ratio contradict each other. The problem whether or not nuclei with $Z > 30$ exist in cos-

Card 1/4

The Investigation of the Composition of Primary Cosmic Radiation

mic radiation can also be solved by means of artificial earth satellites. The existence of such nuclei in cosmic radiation would, on account of its large interaction cross section and the short range in the interstellar space, indicate an exceptionally large amount of heavy elements existing in the sources of cosmic radiation.

The experimental data on the composition of primary radiation. The results of the experiments carried out in 1952 - 1953 have already been published in form of a collection of articles. The respective results obtained within the last years have been compiled in two tables. The importance of the geographical location of the place of observation in the case of equal geomagnetic latitude is pointed out. From the point of view of determining the energy spectrum of the various nuclear groups in primary cosmic radiation, with the help of artificial earth satellites afford great possibilities, because in this way the intensity of the fluxes of the particles with various energies (even at different widths) can be determined by means of the same devices. This, naturally, will considerably increase the reliability of the data obtained concerning the energy spectrum of the primary nuclei. One of the most interesting problems of primary cosmic radiation is the determination of

The Investigation of the Composition of Primary Cosmic Radiation

the amount of the nuclei of the group Li, Be, B. 53-1a-9/18

The experimental method for the study of the charge spectrum of nuclei in primary cosmic radiation. Such methods are of advantage as do not discriminate the particles with respect to their charge and mass. The use of particle counters in the case of which, on the occasion of the passage of a particle, the produced pulse depends upon the charge of the particle, forms part of this method. The application of such devices to an artificial earth satellite is, besides, of advantage in-so-far as the measured data can be telegraphed to the earth. The disadvantages of methods which are based upon the ionization of a medium by rapidly charged particles, are enumerated. The CHEREKOV counter is free from such disadvantages. The conditions to be fulfilled when measuring by this method, are enumerated. The apparatus is disdussed on the basis of a drawing. During the time of observation of one week about 1000 nuclei with $Z \geq 6$ cm, 7000 α-particles and a corresponding number of Li-, Be- and B-nuclei can be registered. For the experiments it is intended to register the differential spectrum of the nuclei with respect to Z in the interval from the α-particle up to oxygen. Such a method is realizeable only if the device is able to solve every peak belonging to the various values of Z. The use of artificial satellites offers new possi-

Card 3/4

53-2a-9/18

The Investigation of the Composition of Primary Cosmic Radiation

bilities for the investigation of the primary cosmic radiation: viz. measuring of the primary proton flux, explaining of the part played by the "albedo" of the atmosphere of the earth, the determination of the lower limit of the electron-positron components, the study of the interaction of the primary particles with matter and the variations with respect to time of intensity. (With 7 illustrations and 4 tables).

ASSOCIATION Not given
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Card 4/4

SOV/20-120-6-18/59

AUTHORS: Vernov, S. N., Corresponding Member, Academy of Sciences, USSR, Grigorov, N. L., Logachev, Yu. I. Chudakov, A. Ye.

TITLE: Measurement of Cosmic Radiation by the Sputnik (Izmereniye kosmicheskogo izlucheniya na iskusstvennom sputnike zemli)

PERIODICAL: Doklady Akademii nauk SSSR, 1958, Vol 120, Nr 6, pp. 1231 - 1233 (USSR)

ABSTRACT: The results discussed in this paper were obtained by equipment incorporated in the second earth satellite. In order to be able to record the variations of the intensity of the cosmic radiation in a reliable manner two similar counters for charged particles (with a length of 100 mm and a diameter of 18 mm) was mounted in the sputnik. Both devices contained counters operating on the basis of semi-conductor triodes. The power consumption of the whole apparatus was 0,15 Watts. The batteries permitted continuous operation for 200 hours. The relative increase of the intensity with altitude was computed from the ratio of the intensity of cosmic radiation on the "inverse loops" (passage from the North to the South, at an altitude of 350 - 700 km) and the intensity on the "direct loops"

Card 1/3

(passage from the South to the North at an altitude of 225 - 240 km) measured at the same geographical points. This variation can be caused by at least three effects: 1) An increase of intensity due to a reduction of the shielding by the earth. 2) A reduction of the intensity by the weakening of the earth's magnetic field 3) By a variation in the albedo of the cosmic radiation. The dependence of the intensity upon the altitude can be explained by the first two effects. From the data obtained by the measurements of many loops the lines of equal intensity of cosmic radiation (isocosmic lines) are obtained. Such isocosmic lines are presented for three different counting rates. The experimental points above all fit upon the geographical parallels. The line of the minimum intensity of cosmic radiation (the "cosmic equator") does not coincide with the geomagnetic equator. According to the evidence obtained the intensity of the cosmic radiation sometimes increased considerably. During this the intensity fluctuated very much. There are 4 figures and 3 references, 1 of which is Soviet.

SUBMITTED: May 4, 1958
Card 2/3

21(7) SOV/20-122-5-11/56

AUTHORS: Vernov, S. N., Corresponding Member, Academy of Sciences, USSR, Tulinov, V. F., Charakhch'yan, A. N.

TITLE: The 27-Day Variations of the Intensity of Cosmic Radiations in the Stratosphere (27-dnevnyye variatsii intensivnosti kosmicheskikh luchey v stratosfere)

PERIODICAL: Doklady Akademii nauk SSSR, 1958, Vol 122, Nr 5, pp 788 - 791 (USSR)

ABSTRACT: The authors carried out a long series of measurements of the intensity of cosmic radiation in the stratosphere by means of spherical probes. These measurements form part of the program of the International Geophysical Year; they were duly begun on July 1, 1957 at two geomagnetic latitudes: 1) near Moscow ($\lambda = 51^{\circ}$, station Dolgoprudnaya, Nauchnaya stantsiya Fizicheskogo instituta AN SSSR)(Scientific Station of the Physics Institute AS USSR) and 2) near Murmansk ($\lambda = 64^{\circ}$, station Loparskaya, Severnaya

Card 1/4

The 27-Day Variations of the Intensity of Cosmic Radiations in the Stratosphere

SOV/20-122-5-11/56

Nauchnaya Stantsiya AN SSSR (Northern Scientific Station AS USSR)). The present paper gives some results obtained by measurements carried out at the latitude of 51° from July 1, 1957 to February 1, 1958, and at the latitude of 64° from July 1, 1957 to October 1, 1957. These measurements were carried out by means of the radiometeorograph RK-1, which contained a thin-walled self-quenched counter of the type STS-6. The pulses of this counter were transmitted by means of a radio-transmitter. A short report is made on the measurements of the height and on the gauging of the counters. The authors describe the results relating to the maximum of the intensity curve in the pressure interval of 50-90 g/cm^2. These results, which are shown by a diagram, seem to indicate a periodicity in the variations of the intensity of cosmic radiation in the stratosphere, viz. for both of the aforementioned latitudes. In the stratosphere the amplitude of the wave is from 8 to 10 times as great as the amplitude of the

Card 2/4

wave on sea level. Therefore the variations investigated are to a great extent caused by the primary cosmic particles of low energies. According to the data available for magnetic storms there is not in every case a connection between the variation of the intensity of cosmic radiation and the existence of magnetic storms. A semiperiod of the aforementioned variations lasted 14.3± 1 days. Next, a procedure for the more exact determination of this period is discussed. The authors thank P.N.Ageshin, V.V.Bayarevich, A.G.Bednyakov, V.A.Gladyshev, A.N. Istratova, A.F.Krasotkin, Yu.N. Komarov, F.Kh.Mochakov, I.K.Marshanov, and G.V. Churbanova for preparing the apparatus and for carrying out the experiments; they further thank Ye.S.Glokova, L.I. Dorman, and A.Ye.Chudakov for their discuss ng the results obtained . There are 3 figures and 5 references, 2 of which are Soviet.

The 27-Day Variations of the Intensity of Cosmic Radiations in the Stratosphere

SOV/20-122-5-11/56

ASSOCIATION: Fizicheskiy institut im. P.N.Lebedeva Akademii nauk SSSR (Physics Institute imeni P.N.Lebedev of the Academy of Sciences USSR)

SUBMITTED: May 24, 1958

Card 4/4

VERNOV, S.N.; VAKULOV, P.V.; GORCHAKOV, Ye.V.; LOGACHEV, Yu.I.; CHUDAKOV, A.Ye.

Studying the soft component of cosmic rays beyond the atmosphere limit. Isk.sput.Zem. no.2:61-69 '58. (MIRA 12:5)
(Cosmic rays) (Artificial satellites)

VERNOV, S.N.

29(2) PHASE I BOOK EXPLOITATION SOV/2594

Akademiya nauk SSSR

Iskusstvennyye sputniki zemli. vyp. 2: Rezul'taty nauchnykh issledovaniy, poluchennyye pri pomoshchi tret'yego iskusstvennogo sputnika zemli (Artificial Earth Satellites. No 2: Results of Scientific Studies Obtained by the Third Earth Satellite) Moscow, Izd-vo AN SSSR, 1958. 82 p. 3,500 copies printed.

Ed.: L. V. Kurnosova; Ed. of Publishing House: D. M. Alekseyev; Tech. Ed.: Yu. V. Rylina.

PURPOSE: This work is intended for geophysicists, meteorologists, and other scientific and technical personnel engaged in space exploration and research.

COVERAGE: This collection of articles containscertain of the scientific findings recorded by the third Soviet space satellite. Much corroborating data from other rocket and satellite investigations are included. The articles are based on papers originally read at the Fifth Assembly of the

Card 1/4

of the Special IGY Committee held in Moscow in August, 1958. Individual articles discuss the ionic composition and density of the atmosphere, the thermodynamic parameters of the stratosphere, and questions dealing with the motion of the satellite. References accompany each article.

Artificial Earth Satellites (Cont.) SOV/2594

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Card 4/4

VERNOV S.N.

29(0) PHASE I BOOK EXPLOITATION SOV/1658

Akademiya nauk SSSR

Iskusstvennyye sputniki zemli, vyp. 1: Rezul'taty nauchnykh issledovaniy, provedennykh po programe MGG pri pomoshchi pervogo i vtorogo iskusstvennykh sputnikov zemli (Artificial Earth Satellites, Nr 1: Results of Scientific Studies Carried Out in Accordance With the IGY Program by Means of the First and Second Artificial Earth Satellites) Moscow, Izd-vo AN SSSR, 1958. 95 p. 3,500 copies printed. [Microfilm and Zerox Copy]

Resp. Ed.: L.V. Kurnosova; Ed. of Publishing House: D.M. Alekseyev; Tech. Ed.: T.V. Polyakova.

PURPOSE: This collection of articles is the first in a series to be published regularly and is intended to disseminate to the scientific community data collected in investigations performed by means of artificial earth satellites.

COVERAGE: This collection includes papers covering scientific data obtained from the first and second Soviet artificial earth satellites. Among the areas reported on are measurements of cosmic radiation, atmospheric density, electron

Card 1/15

concentration in the ionosphere, and biological studies of an animal occupant of a satellite. Papers on the motions and perturbations of satellite orbits and optical and Doppler methods of satellite tracking are also included. Coverage of the individual articles is given in the Table of Contents.

TABLE OF CONTENTS:

variation of cosmic-ray intensity as a function of altitude for the same geographic points. The intensity was found to increase considerably between 225 and 700 km, the highest altitude achieved by the satellite. This variation is attributed to three causes: a) decreased screening by the earth, b) reduction in the magnetic field of the earth permitting penetration of lower-energy particles, and c) change in the albedo of cosmic radiation. 5
There are 3 references, 1 of which is Soviet, 1 English, 1 a translation from English.

Lidov, M.L. Determination of the Density of the Atmosphere From the Observed Decelerations of the First Artificial Satellites 9

This paper presents equations relating the elements of a satellite orbit to atmospheric density. The analytical procedures used in reducing observed data on the evolution of the satellite orbit are given including an evaluation of the approximations used in obtaining solutions to the equations involved. It was assumed that in the range of altitudes considered (228-368 km) the variation of density with altitude could be approximated by the exponential function $\rho = \rho_{\pi} e^{-\frac{z - z_{\pi}}{H}}$

where ρ is the density at altitude z, ρ_{π} is the density at the perigee altitude z_{π}, and H is the altitude of the homogeneous

VERNOV, S. N. and CHUDAKOV, A.,

"Cosmic Ray and Photon Measurements from Satellites," paper presented at 10th General Assembly, Int'l Astronomical Union, Moscow, Aug 1958.

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A005/A001

Translation from: Referativnyy zhurnal, Geofizika, 1960, No. 12, p. 219, # 16279

AUTHORS: Blokh, Ya. L., Vernov, S. N., Dorman, L. I., Dubrovin, M. M.

TITLE: Preliminary Results of an Investigation of the Underground Variations of Cosmic Rays

PERIODICAL: V sb.: Variatsii kosmich. luchey pod zemley, na urovne morya i v stratosfere. No. 1, Moscow, AN SSSR, 1959, pp. 37-47

TEXT: The variations of the cosmic ray intensity are investigated on the basis of data obtained from a counter telescope of triple coincidences, which was located under the earth's surface at the depth of 40 m of water equivalent. By the simple-correlation method the value of the barometric coefficient $\beta = (0.021 \pm 0.008)$ %/mb was obtained. The diurnal variation of the underground intensity amounts to about 0.05%. By averaging the data it is shown that the average effect at the depth of 40 m of water equivalent amounts to 0.3% during 11 events of decreases of the Forbush type. The investigation of the disturbed diurnal variations in the cosmic ray intensity was also carried out. N. K.

Translator's note: This is the full translation of the original Russian abstract.

Card 1/1

21(6)

AUTHORS: Vernov, S. N., Corresponding Member, SOV/20-124-5-17/62
AS USSR, Grigorov, N. L., Ivanenko, I. P., Lebedinskiy, A. I., Murzin, V. S., Chudakov, A. Ye.

TITLE: A Possible Mechanism of the Production of "Terrestrial Corpuscular Radiation" Under the Action of Cosmic Rays (Vozmozhnyy mekhanizm sozdaniya "zemnogo korpuskulyarnogo izlucheniya" pod deystviyem kosmicheskikh luchey)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 124, Nr 5, pp 1022-1025 (USSR)

ABSTRACT: By "terrestrial corpuscular radiation" the authors mean the fluxes of particles moving in the terrestrial magnetic field along closed orbits. According to the authors' opinion, the following radiation production mechanism deserves the most attention: Under the action of cosmic radiation, the earth, like any other celestial body, becomes a neutron source. The neutrons traverse the magnetic field without being disturbed as uncharged particles and attain great distances from the earth. The charged particles originating from neutron decay move in the magnetic field along the lines of force. The particle in the course of time reaches the region of high geomagnetic

Card 1/4

latitudes, where fieldstrength increases considerably with increasing latitude. In this region the velocity vector of the particle will, as the particle approaches the earth, turn so long with respect to the vector $\vec{H}$, until at the latitude λ_{max} the angle between the velocity of the particle and the vector $\vec{H}$ becomes equal to 90°. At this point the particle returns and begins to move in the rear direction along the same magnetic line of force. If conditions are favourable, the decay products of the neutrons may perform 10^{8} and more oscillations between the northern and the southern turning point. Therefore, the intensity of the flux of these particles increases by the same amount. Experimental data indicate the existence of such a radiation. The present paper carries out a closer investigation in order to find out by what factors the intensity of these rays is determined. Calculation is followed step by step. The authors calculate the intensity of the "terrestrial

corpuscular radiation" for various heights and latitudes; the results obtained by these calculations are shown by a diagram. They lead to the following conclusions: Although the number of neutrons decaying in the earth is very small, they may cause intensive cosmic radiation. The experimentally determined intensity is by ~ 100 times lower near the equator than calculated intensity. According to experimental data there is no terrestrial corpuscular radiation in geomagnetic latitudes above 40°, but in the present paper $j(\lambda = 40^{\circ}) \sim j(\lambda = 0^{\circ})$ is obtained. This means non-agreement by more than 10^5 times the amount. In order to reestablish agreement with the experiment, it is useful to assume an additional flux of particles from "magnetic traps", which are particularly strong in large latitudes. This may be due to the existence of electric fields. This assumption also appears to be confirmed by the data concerning the considerable increase of perturbations of the terrestrial magnetic field with increasing latitude. With increasing latitude, the interdictions imposed upon energy by Stoermer's theory are being disobeyed to an ever-increasing extent. The

mechanism discussed in the present paper must apply also in the neighborhood of astrophysical objects having a magnetic field. Therefore, the investigation of this radiation in the neighborhood of planets may be a means of observing weak magnetic fields. The authors thank D. V. Skobel'tsyn for his advice and M. S. Rabinovich for discussions. There are 2 figures and 7 Soviet references.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet im. M. V. Lomonosova (Moscow State University imeni M. V. Lomonosov)

SUBMITTED: November 21, 1958

SOV/20-125-2-16/64

24(7),24(8)

AUTHORS: Vernov, S.N., Corresponding Member, AS USSR, Chudakov, A.Ye., Vakulov,P.V., Logachev, Yu.I.

TITLE: Investigation of Terrestrial Corpuscular Radiation and of Cosmic Rays During the Flight of a Cosmic Rocket (Izucheniye zemnogo korpuskulyarnogo izlucheniya i kosmicheskikh luchey pri polete kosmicheskoy rakety)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 125, Nr 2, pp 304 - 307 (USSR)

ABSTRACT: The rocket launched on January 2, 1959 in the direction of the moon had apparatus for recording cosmic- and terrestrial corpuscular radiation on board. By the latter the authors mean the fluxes of fast charged particles in great altitudes, for which the terrestrial magnetic field is a so-called "magnetic trap". The particles were recorded by 2 Geiger-counters and 2 scintillation-counters. The first apparatus, with scintillation counter, was a constructive further-development of the device which the authors had built into the third Soviet Sputnik. A cylindrical sodium-iodide crystal served as a detector. The authors, above all, described the results obtained by the preliminary evaluation of the data ascertained in altitudes of from 8000 to 150000 km (from the center of the earth). A schematical drawing shows the trajectory of the rocket with

Card 1/3

respect to the terrestrial magnetic field. The intensity maximum is ~26000 km from the center of the earth. At a distance of 55000 km the intensity of terrestrial corpuscular radiation becomes practically equal to zero, and the remaining ionization in this distance is entirely due to cosmic radiation. According to the authors' opinion the particles oscillate along the lines of force symmetrically to the equatorial plane. The increase of intensity along a given line of force in the transition from low to high altitudes serves as an experimental proof for this assumption. The particle flux is directed not only towards one side, and, in any case, the predominant part of the particles undergoes complete reflection when approaching the earth, and is therefore subjected to oscillations from one hemisphere to the other. The trajectory of the rocket nowhere intersects the so-called internal zone. Actually, the apparatus built into the cosmic rocket in no range of their trajectory record particles of high energy which are characteristic of the inner zone. On the other hand, the composition of radiation is very similar to that observed by means of the third Sputnik in polar regions. Next, the composition of radiation in the outer zone with

Investigation of Radiation and of

Terrestrial Corpuscular Cosmic Rays During the Flight of a Cosmic Rocket

SOV/20-125-2-16/64

high intensity is dealt with. In the center of the outer zone, where particle density is the greatest, the effective energy of electrons is minimal. In conclusion, cosmic radiation is dealt with. Beginning with a distance of 66000 km, the intensity of all components remains constant. The strict constants of all components at distances of from 66000 to 150000 km indicates the existence of a radiation upon which the terrestrial magnetic field exercises no influence. Therefore, either the terrestrial magnetic field vanishes at a distance of 10 earth-radii, or there are no particles with momenta of

$1.5.10^8$ to 4.10^7 ev/c in interplanetary space. The energy-flux of the photons is very low and contributes partly nothing to ionization. There are 2 figures and 4 Soviet references.

SUBMITTED: February 25, 1959

Card 3/3

VERNOV, S.

PHASE I BOOK EXPLOITATION SOV/4890

Pravda

Besprimernyy nauchnyy podvig; materialy gazety "Pravda" o trekh sovetskikh kosmicheskikh raketakh (Unparalleled Scientific Achievement: Materials From "Pravda" on 3 Soviet Cosmic Rockets) Moscow, Gos. izd-vo fiziko-matematicheskoy lit-ry, 1959. 202 p. 50,000 copies printed.

PURPOSE: This book is intended for the general reader.

COVERAGE: The book contains articles from "Pravda", announcing the launching of three Soviet cosmic rockets on 2 January, 12 September, and 4 October 1959. Articles which describe details and observations of the flights of the rockets are included and are illustrated by diagrams and photographs. The book contains nontechnical contributions by several Soviet scientists. No personalities are mentioned. There are no references.

TABLE OF CONTENTS:

1/4

Unparalleled Scientific (Cont.) SOV/4890

THIRD SOVIET COSMIC ROCKET

AVAILABLE: Library of Congress (TL796.5.R8P66)

Card 4/4

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D299/D304

3.2410 (1559, 2205, 2705, 2805)

AUTHORS: Vernov, S. N., Khristiansen, G.B., Abrosimov, A. T., Goryunov, N. N., Dmitriyev, V. A., Kulikov, G. B., Nechin, Yu. A., Sokolov, S. P. (deceased), Solov'yeva, V. I., Solov'yev, K. I., Strugals'kiy, Z. S., and Khrenov, B. A.

TITLE: General description of the setup used for studying extensive air showers and the provisional results obtained

SOURCE: International Conference on Cosmic Radiation. Moscow, 1959. Trudy. v. 2. Shirokiye atmosfernyye livni i kaskadnyye protesessy, 5-16

TEXT: A complex experimental setup was installed at Moscow State University, consisting of a simultaneously operating physical apparatus plus the corresponding radiotechnical equipment and photographical recording devices. The setup incorporates over 5000 Geiger-Müller counters (forming a hodoscope), about 150 ionization

Card 1/7

General description of the setup...

chambers and a large diffusion chamber. The setup is designed for a comprehensive and simultaneous investigation of all the basic components (electrons and photons, nuclear-active particles and μ-mesons) of extensive air showers at sea level. The setup was designed in 2 different configurations: the first at the end of 1957, and the second at the beginning of 1959. Below, only the results obtained by means of the first setup are considered. The setup was located in a special building and in 10 mobile laboratories. The showers were registered by the system of hodoscoped counters. Part of the counters were shielded (those for detecting the nuclearactive particles and the μ-mesons) and the other counters were not shielded. The ionization chambers served to determine the lateral distribution of the electron-photon component and of the nuclearactive component. The microstructure of the electron component was studied by means of the diffusion chamber. Special measures were taken to ensure continuous and prolonged operation of the setup. The main units of the setup were automatically controlled, in particular the supply units and the photography system. The operation of the setup (as a whole) was controlled (triggered) by a selection system; in parti-

General description of the setup ...

cular, the showers were selected in accordance with the density of the electron flow and of the μ-mesons. The setup was in operation for about 2500 hours, yielding a large amount of experimental data which are still being processed. The probability theory (Baye's theorem) was used for determining the (x,y)-axes and the number of particles N of the shower; in addition the distribution function f(r) as well as other distribution functions were determined (r denoting distance). The values of x, y and N were found by means of a special electronic simulator. The density distribution of electrons and mesons was determined by means of formula

$$W(\rho) = \prod_i \left[1 - \exp(-\rho\sigma_i)\right]^{m_i} \cdot \exp\left[-\rho\sigma_i(n_i - m_i)\right]$$

where m_i is the number of counters which operate over an area σ_i, and n_i - the overall number of such counters. The energy E of the electron-photon component was determined by means of ionization

Card 3/7

General description of the setup ...

chambers, shielded with lead (up to 5 cm thick). A very comprehensive picture of the particles and energies was obtained for showers whose axes fell within the system of 128 cubic detection chambers. The setup permits observing the central part of an atmospheric shower, whereby its several layers are simultaneously observed; this corresponds to the individual observation of the electron-photon, nucleoactive and μ-meson components. The processed material already yielded a fairly detailed picture of the structure of extensive air showers at sea level. Thus, the lateral distribution of particle flow in the individual showers was ascertained. It was found that the lateral distribution varies (in the 1 to 25 m range) from shower to shower; the average distribution is, in the range of 5 cm to 100 m, as follows:

$$\rho(r) = \begin{cases} \dfrac{K_1 N}{r^{0,6}} & K_1 = 3{,}3 \cdot 10^{-3},\ 0{,}05 < r < 0{,}3 \text{ m} \\ \\ & \text{(cont'd)} \end{cases}$$

Card 4/7

General description of the setup ...

$$\left\{ \frac{K_2 N}{r} \cdot e^{-\frac{r}{60}}, \quad K_2 = 2 \cdot 10^{-3}, \quad 0{,}3 < r < 100 \text{ m} \right.$$

The lateral distribution of the electron-photon components also fluctuates from shower to shower. At distances smaller than 1.5 m, these fluctuations are particularly sharp. The nuclearactive components also exhibits considerable energy fluctuations. The fluctuations in the high-energy μ-mesons were not yet analyzed. The energy of the electron-photon component E_{eph} was calculated for a shower with number of particles equal to $(2.7 \pm 0.2) \cdot N\beta$, where β is the critical energy for air (72 Mev). The above value was obtained with an accuracy of appr. 30%. It was found that the energy of the nuclearactive component $E_n \cong (0.5 \text{ to } 1.0) E_{eph}$. This value is, however, subject to considerable fluctuations and the experimental data are as yet insufficient to determine the contribution of the

Card 5/7

General description of the setup...

nuclearactive component in showers. In addition, the above-mentioned fluctuations severely delimit the choice of a theoretical model for the development of showers. Particular attention was devoted to the structure of the shower in the immediate vicinity of its axis, where the particles of highest (for the particular shower) energy should be concentrated. This led to the discovery of a new effect: Groups of particles (from 4 to 20) travel in narrow beams (not exceeding 8 cm in diameter) in the neighborhood of the axis (or along the axis itself), whereby their lateral distribution shows that the beams are not due to Poisson fluctuations. The new effect can be explained as follows: Either the beam is the core of a "young" electron-photon shower which originates from a high-energy π^0-mesor at a certain distance from the apparatus, or the beam consists of μ-mesons. These two possibilities are discussed. The observed irregularity in the lateral distribution of μ-mesons in the vicinity of the shower axis might be related to the new effect. There are 6 figures and 2 tables.

4

Card 6/7

31519
S/627/60/002/000/001/027
D299/D304

General description of the setup ...

ASSOCIATION: Nauchno-issledovatl'skiy institut yadernoy fiziki MGU, Moskva (Scientific Research Institute of Nuclear Physics Moscow State University, Moscow)

Card 7/7

31526
S/627/60/002/000/008/027
D299/D305

3,2410 (1559, 2205, 1705)

AUTHORS: Vernov, S. N., Goryunov, N. N., Dmitriyev, V. A., Kulikov, G. V., Nechin, Yu. A., Solov"yeva, V. I., Strugal'skiy, Z.S., and Khristiansen, G. B.

TITLE: Study of lateral-distribution function of charged particles and of the energy density of the electron-photon component of extensive air showers

SOURCE: International Conference on Cosmic Radiation. Moscow, 1959. Trudy. v. 2. Shirokiye atmosfernyye livni i kaskadnyye protsessy, 117-122

4

TEXT: The data obtained by means of the diffusion chamber and the hodoscoped counters permit determining the particle distribution in the neighborhood of the shower axis as well as at large distances from it. These data can be used for determining the number of particles and the position of the axis to an accuracy of approximately 1 m by means of the hodoscoped counters, and to an accuracy of several centimeters if the axis lies within the limits of the diffu-

Card 1/5

Study of lateral-distribution ...

sion chamber. The electron-photon component at large distances from the axis was studied by means of large ionization chambers, shielded with lead. During 1000 hours of operation, 28 cases were recorded of the axis (of showers with number of particles $N \geqslant 10^5$) passing through the core detector. All these showers were investigated in detail with respect to distribution and energy of particles. The cases most favorable for analysis are those, in which the shower axis lies in the diffusion chamber. In all, 7 such cases were recorded. For each of these showers, the lateral-distribution function of particle density was constructed for distances ranging from 5 cm to 1 m from the shower axis. It was found that the form of the distribution function varied from shower to shower in the core region. In that region, a peculiar feature of particle distribution was observed, namely a narrow beam (4 cm in diameter) of particles, consisting of a large number (4 to 15) of particles with collinear tracks. From data obtained by means of the hodoscoped counters and knowing the position of the shower axis, it is possible to construct the distribution function of charged particles up to a distance of r = 25 m. from the axis, for each individual

Study of lateral-distribution ...

shower. Then the experimental distribution functions were compared with the theoretical functions of Nishimura and Kamata. The results of the comparison are shown in a table. A difference was noted in the form of the distribution of the energy flux of the electron-photon component in the individual shower at a distance of $r \sim 1$ m, and at large distances from the axis; this is due to local fluctuations in the form of the energy distribution in the core. In each of the investigated showers, the energy flux of the electron-photon component was found within a radius of 25 m; it turned out that the electron-photon component energy-flux was stronger (on the average) in showers with small s, than in showers with large s (s being the "age parameter"). The system of counters permitted recording showers with number of particles $N = 10^4$ to 10^7. The data yielded by the diffusion chamber were used for constructing the distribution function for distances $r < 1$ m from the shower axis. The conclusion was reached that the form of the electron-photon energy distribution-function does not depend on the number of particles in the shower. Therefore, all the data were referred to a shower with same N, and the average energy-density distribu-

Card 3/5

Study of lateral-distribution ...

tion constructed. Approximating this distribution by a power law of type r^{-n}, one obtains for the exponent n the following values (as a function of the distance r from the axis):

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$n = 1,2 \pm 0,2, \quad 0,1 < r < 1$ m

$n = 1,5 \pm 0,2, \quad 1 < r < 10$ m

$n = 2,0 \pm 0,3, \quad 10 < r < 60$ m

$n = 2,6 \pm 0,2, \quad 60 < r < 1000$ m

Further, the mean energy per electron was obtained from experimental and theoretical values (based on the cascade shower theory) of the mean energy as a function of r showed a discrepancy which can be removed by taking into account the effect of nuclear scattering. The experimental values permit calculating the energy of the

Study of the lateral-distribution ...

electron-photon component, viz. $E_{eph} = 2.5 \beta N$, where β denotes the mean energy loss per unit of depth t. There are 2 figures, 1 table and 6 references: 5 Soviet-bloc and 1 non-Soviet-bloc. The reference to the English-language publication reads as follows: J. Nishimura, K. Kamata. Suppl. Theor. Phys., no. 6, 1958.

4

Card 5/5

31527
S/627/60/002/000/009/027
D290/D305

3,2410(1559, 2705, 2805)

AUTHORS: Vernov, S. N., Goryunov, N. N., Dmitriyev, V. A., Kulikov, G. V., Nechin, Yu. A., and Khristiansen, G. B.

TITLE: Study of high-energy nuclearactive component of extensive air showers at sea level

SOURCE: International Conference on Cosmic Radiation. Moscow, 1959, Trudy. v. 2. Shirokiye atmosfernyye livni i kaskadnyye protsessy, 123-131

TEXT: The high-energy nuclearactive component was studied by the apparatus of Moscow State University. The nuclearactive component was detected and measured by means of hodoscoped counters and ionization chambers. The processed hodoscope data permitted determining the total number of particles N and the distance R_i of the shower axis from the ionization chambers. Part of the data were processed by the electronic computer of Moscow State University; thereby the number of particles was determined to an accuracy of approximately

4

Card 1/4

Study of high-energy ...

20%, and the position of the axis to within 0.25 m, provided it fell inside the area of a detector of 4 m^2. The joint processing of the data of the hodoscope and ionization chambers yielded the mean energy of the nuclearactive component of showers of various number of particles, the energy spectra of the nuclearactive particles in the central part of the shower, the lateral distribution of the energy flux carried by the nuclearactive component in the central part of the shower and the lateral distribution of the nuclearactive particles. Showers, whose axes were at a distance of less than 10 m from the detector of nuclearactive particles, were selected for further study. These showers were divided into 4 groups according to number of particles; over 1000 such showers were investigated. The integral spectra of nuclearactive particles of energies $E_{na} \leqslant 10^{12}$ ev. were obtained for the 4 groups. The integral spectra of nuclearactive particles, averaged over the showers of all the groups, can be approximated by an exponential function with exponent $\gamma = -1.0 \pm 0.2$. For showers with large N (group 4), the value of γ shows a decreasing tendency. The space distribution of the energy flux near the

Card 2/ 4

Study of high-energy ...

axis can be approximated by an exponential function with exponent $n = -1.5 + 0.2$. A typical correlation was established between the electron-photon and the nuclearactive components of cores of the individual showers, namely showers with an electron-photon component of an energy much higher than the average, have (as a rule) a nuclearactive component of lesser energy. The converse was also observed. The measurements gave direct evidence of the presence of nuclearactive particles of high-energy ($\sim 10^{12}$ ev.) in showers at sea level, and of the considerable importance of the nuclearactive component in the energy balance of the shower. The nuclearactive component in the central part of the shower carries an energy which is (on the average) almost as large as the entire energy of the electron-photon component at the level of observation. The presence of considerable energy in the nuclearactive component affects the absorption of particles in the shower. The development of individual showers can differ considerably, as the magnitude of the energy of the nuclearactive component differs considerably in the individual showers. The main contribution to the energy flux carried by the nu-

Card 3/4

Study of high-energy ...

clearactive component within a circle of given radius is made by high-energy particles, whose lateral distribution is such that, on the average, all the particles with energy $\geq 10^{12}$ ev. are contained in a circle of radius r = 1 m. The distribution of the energy flux carried by the nuclearactive component showed that this flux is fairly widely distributed. Further, the transverse momentum imparted to the particles (during their generation), was estimated. The nuclearactive component of showers with N = 10^4 to 10^6 at sea level carries an energy of 0.5 to 1.0 of the total energy, carried by the electron-photon component. As a result of the energy fluctuations of the nuclearactive component in the individual showers, the development of the showers fluctuates, too. The distribution of the energy flux of the nuclearactive component over a region of $1 \leq r < 20$ m near the axis is described by the law $r^{-2\pm0.25}$; such a distribution should affect the characteristics of the soft component. There are 4 figures, 1 table and 10 references: 9 Soviet-bloc and 1 non-Soviet-bloc. The reference to the English-language publication reads as follows: J. Nishimura, K. Kamanta.Suppl. Prog.Phys.,no.6, 1958.

Card 4/4

31533
S/627/60/002/000/016/027
D299/D304

3.2410 (2205, 2705, 2805)

AUTHORS: Vernov, S. N., Tulupov, V. I., Khrenov, B. A., and Khristiansen, G. B.

TITLE: Investigating high-energy μ-meson component of extensive air showers

SOURCE: International Conference on Cosmic Radiation. Moscow, 1959. Trudy. v. 2. Shirokiye atmosfernyye livni i kaskadnyye protsessy, 169-180

4

TEXT: The selection of μ-mesons of various energies was carried out by recording them at various depths of the absorber. The peculiar feature of the experiments consisted in the need to select showers, whose axes pass at various distances from the meson detectors, so as to study the space distribution of the meson flow. Thereby, the distance between the underground detectors and the shower axis recorded at the surface, may largely depend on the inclination of the shower axis. The apparatus made it possible to determine the mean density of meson flow with treshold energies

Card 1/4

Investigating high-energy ...

E_μ equal to 0.4, 5, and 10 Bev, at distances of 100, 25, and below 25 m, for showers of various number of particles. The detectors with a large sensitive area permitted observing the peculiarities of meson distribution in the various showers. The apparatus was in operation for approximately 2000 hours. The energy spectra of the μ-mesons and their lateral distribution for distances of 3 - 100 m from the shower axis were obtained. It was found that for showers with $N = 2 \cdot 10^5$, the lateral distribution of μ-mesons with $E_\mu \geq 10$ Bev has an exponent $n \leq 1$ for distances up to 100 m. This means that μ-mesons of such energies are mainly found outside a circle of radius r = 100 m. Further, the irregularities of meson-distribution at a depth of 40 m were studied in individual showers by means of meson detectors of total area 3.1 m^2. Irregularly distributed meson-groups were observed. In all, 17 such groups were recorded in 14 showers, during 800 hours of operation of the detectors. The pertinent experimental results are listed in tables. It was found that the meson groups appear in showers which do not differ from "aver-

Card 2/4

Investigating high-energy ...

age" showers with respect to the total meson-flow. The distance between the meson group and the shower axis did not exceed 3 m for showers with $N = 2 \cdot 10^5$. A comprehensive knowledge of the high-energy meson component was obtained, in particular with respect to meson flow in the vicinity of the shower axis, where the energy of the μ-mesons exceeds 10 Bev. By comparing the number of mesons at mountain altitude and at sea level, the conclusion is reached that μ-mesons with $E_\mu \geq 10$ Bev. are effectively generated at high altitudes (above 3800 m), acquiring a sufficiently large transverse momentum. The character of the lateral distribution of μ-mesons near the shower axis is determined by the character of meson generation according to altitude. Computations were carried out of meson distribution near the axis ($r \leq 25$m), with $E_\mu > 10$ Bev, for 2 models of extensive shower development. Further, various interpretations are proposed for the appearance of μ-meson groups in the vicinity of the shower axis. The angular distribution of π-mesons in nuclear interactions has a substantial effect on the lateral distribution of μ-mesons with $E_\mu > 10$ Bev. The majority of μ-mesons of such ener-

Card 3/4

Investigating high-energy...

gies are generated at altitudes of 6 - 8 km above sea level. The dependence of the number of μ-mesons with $E_\mu \geqslant 10$ Bev. on the number of particles in the shower, in the circle $r = 25$ m, is expressed by $N^{0.6 \pm 0.1}$ (for the range $N = 10^4$ to $5 \cdot 10^5$). The meson distribution (with $E_\mu \geqslant 10$ Bev.) in showers with $N = 2 \cdot 10^5$ is expressed by $\rho_\mu = K/r^n$, $n = 0.8 \pm 0.2$, for distances of 3 to 10 m from the shower axis. There are 6 figures, 6 tables and 10 references: 8 Soviet-bloc and 2 non-Soviet-bloc. The references to the English-language publications read as follows: B. Edwards, J. Losty, D. H. Perkins, P. Pinkau, J. Reynolds. Phil. Mag., 3, 237, 1958; A. Ueda, N. Ogita. Progr. Theor. Phys., 18, 269, 1957.

Card 4/4

SOV/56-36-3-4/71

21(7)

AUTHORS: Vernov, S. N., Goryunov, N. N., Zatsepin, G. T., Kulikov, G.V., Nechin, Yu. A., Strugal'skiy, Z. S., Khristiansen, G. B.

TITLE: Investigation of the Core of Extensive Atmospheric Showers (Issledovaniye stvola shirokogo atmosfernogo livnya)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 36, Nr 3, pp 669-681 (USSR)

ABSTRACT: The group of research scientists followed a suggestion made by D. V. Skobel'tsyn to investigate the passage of extensive atmospheric showers through matter simultaneously in different depths; in this connection an investigation of the shower core was carried out. Figure 1 shows a block scheme of the experimental arrangement used, which furnished data concerning the electron-photon and the nuclear-active components of the shower core. The experimental system consisted essentially of a diffusion chamber (0.64 m^2), 124 ionization chambers in hodoscope-connection, special filters and 672 Geiger-Mueller (Geyger, Myuller) hodoscope counters of different sizes. The method, which is described as new, is described in detail,

Card 1/4

Investigation of the Core of Extensive Atmospheric Showers

and the possibilities it offers are discussed. The entire device remained in operation for 1300 hours and recorded more than 10,000 passages of extensive air showers. Within 1,000 hours 28 passages of shower cores with a shower particle number of $N > 10^5$ through the first row of ionization chambers were recorded. Figure 4 shows a photograph of the diffusion chamber for such a passage and the corresponding pulse oscillogram of 64 ionization chambers. The article gives numerous individual data concerning different showers as e.g. the ionization distribution in the 64 ionization chambers of the first and second row respectively for $N = 5.10^5$, $1.3.10^5$ and $N \approx 10^5$ with a spatial distribution of energy flux $\sim 1/r^3$ (Fig 6). Figure 8 shows the same, expressed by the number of relativistic particles passing through the ionization chambers of the first and second row for $N = 10^4$ and 2.10^4 and an energy flux $\sim 1/r^2$ and $\sim 1/r$. Figures 6 and 8 show the particle flux distribution in the diffusion chamber for $N = 2.10^6$ and $3.5.10^4$ respectively. In extensive air

Investigation of the Core of Extensive Atmospheric Showers

showers with $N > 10^5$ it was observed in the shower core ($r < 1$m) that the total energy of nuclear-active particles is of the order of the energy of the electron-photon component at the same distance from the axis; for individual showers, however, the ratio of these energies showed different values. The energy current density of the electron-photon component shows an increase of up to r = 20 + 30 cm from the shower axis; the course of energy flux density in dependence on r cannot be represented by a general formula. It fluctuates between $\sim 1/r$ and $\sim 1/r^3$. The energy fluxes of electron-photon and nuclear-active components of the shower core show considerable fluctuations (up to 10 times). The authors finally thank Academician D. V. Skobel'tsyn for his help and interest, V. V. Borisoglebskiy for his collaboration, Professor N. A. Dobrotin for his help and discussions, and further also a group of collaborators of the MGU: A. T. Abrosimov, S. S. Glagolevskiy, B. V. Subbotin, A. D. Yerlykin, A. B. Kamnev, E. N. Sosnov for their help in carrying out experiments. There are 8 figures, 2 tables, and 12 references, 11 of which are Soviet.

Card 3/4

SOV/56-36-3-4/71

Investigation of the Core of Extensive Atmospheric Showers

ASSOCIATION: Moskovskiy gosudarstvennyy universitet
(Moscow State University)
Fizicheskiy institut im. P. N. Lebedeva Akademii nauk SSSR
(Physics Institute imeni P. N. Lebedev of the Academy of Sciences, USSR)

SUBMITTED: July 21, 1958

Card 4/4

SOV/56-36-4-2/70

21(1)

AUTHORS: Vernov, S. N., Babetskiy, Ya. S., Goryunov, N. N., Kulikov, G. V., Nechin, Yu. A., Strugal'skiy, Z. S., Khristiansen, G. B.

TITLE: On the Structure of the Core and the Central Regions of Extensive Atmospheric Showers at Sea Level (O strukture stvola i tsentral'nykh oblastey shirokikh atmosfernykh livney na urovne morya)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 36, Nr 4, pp 976-984 (USSR)

ABSTRACT: The object of the present paper was an experimental investigation of the spatial distribution of the energy flux of the electron-photon and the nuclear-active component in the core and the central regions of extensive air showers; the present paper is a continuation of an article published in the preceding issue of this periodical (Ref 1), in which the method and the experimental arrangement were already described. Figure 1 is a schematical representation of the chamber system with the distribution of hodoscope counters. The counters were located in groups of 12 and 24 in containers. The ionization chambers had a total area of 4 m^2. In the course of the 1800 hours during which the apparatus was in operation, about 18000

Card 1/4

On the Structure of the Core and the Central Regions of Extensive Atmospheric Showers at Sea Level

showers were recorded, with particle numbers of between 10^3 and 10^6, and axes which were at a distance of up to 30 m from the system of ionization chambers. From the manifold material obtained by these investigations the spatial distribution obtained for individual showers or groups of showers (classification according to particle number N) are analyzed. For spatial particle flux density it holds that $\varrho(r) \approx 2.10^{-3} N/r$ for $r < 10$ m, for the energy flux density: $\varrho_E(r) \sim r^{-n}$. For shower groups of different sizes (ΔN from $1.0.10^5$ - $5.0.10^5$ up to 5.10^3 - 5.10^5) table 1 shows how many of the total of 82 investigated showers correspond to certain n-values (from < 0.8 to 3.2 - 3.4). Figure 2 (a,b) shows the spatial distribution of the energy flux of electron-photon and nuclear-active components of two different shower groups, figure 3 shows the energy spectrum of the nuclear-active component in the shower cores, and figure 4 shows the distribution of the absolute values of the energy flux of the electron-photon component in a circle with the radius 1.5 m round the axis of a shower with $\bar{N} = 10^5$ particles. The diagram is characteristic of the strong oscillations ob-

served. Figure 5 finally shows the spatial energy flux distribution within the range of from 0.1 to 30 m; the measured values (in a semilogarithmic diagram) are practically on a steeply declining straight line. Thus, the following is obtained for the electron-photon component:

$$\varrho_{e\text{-}ph} \sim 1/r^{1.35} \quad \text{at} \quad 0.1\ m < r < 2.0\ m$$

$$\varrho_{e\text{-}ph} \sim 1/r^{2} \quad \text{at} \quad 2.0\ m < r < 30\ m$$

and for the nuclear-active component: $\varrho_{n\text{-}a} \sim 1/r^2$ at $0.2m < r < 30m$. Figure 6 again shows the spatial distribution of the absolute values of energy flux in a distance of 10 m from the shower core; like within the range of the core itself, oscillations are considerable. The authors finally thank G. T.Zatsepin and I. P. Ivanenko for advice and discussions. There are 6 figures, 3 tables, and 3 Soviet references.

ASSOCIATION: Institut yadernoy fiziki Moskovskogo gosudarstvennogo universiteta (Institute for Nuclear Physics of Moscow State University)

Card 3/4

21(0)

AUTHORS: Vernov, S. N., Gorchakov, Ye. V., Ivanenko, I. P., Khristiansen, G. B.

SOV/56-36-4-39/70

TITLE: On the Development of the Nuclear- Active Components in Extensive Atmospheric Showers (O razvitii yaderno-aktivnoy komponenty shirokikh atmosfernykh livney)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 36, Nr 4, pp 1233-1239 (USSR)

ABSTRACT: Already Guzhavin, Guzhavina and Zatsepin (Ref 1) calculated the height dependence of high-energy nuclear-active particles and the number of high-energy μ-mesons at sea level, as well as the height-dependence of the nuclear-active and of the soft component of extensive air showers. The elementary act was calculated according to Landau (Ref 2) and Vernov (Ref 3). For all energies the collision cross sections were calculated, and for the free path in air the value $\lambda_0 = 65 \div 70$ g/cm^2 was obtained. The results of calculations depend in a high degree on λ_0; however,

Card 1/3

λ_0 is at energies of $\approx 10^{10}$ ev not known from experiments. Therefore, the authors of this paper calculated different characteristics for the nuclear-active (n.a.) component of extensive air showers (e.a.sh.), in which λ_0 is determined by the type of the elementary act and the experimental range of the absorption of n.a. particles ($E \approx 10^{12}$ ev). By making simple assumptions concerning the nature of the elementary act the spectrum of the n.a. particles in e. a. sh. was computed, and likewise the ranges for the absorption of n.a. particles and the energy fluxes in the showers. Also the probability for the observation of one or two high-energy n.a. particles in a given altitude is estimated. The main aim of this paper was to find characteristics of the e. a. sh. for various parameters of the elementary act and λ_0, which are sensitive to the nature of interation.

It was found that besides the e.a.sh. characteristics, which depend only weakly on the nature of the elementary particle, there exist also such as are highly dependent. An exact experimental investigation of the latter may lead to important results concerning the elementary act.

On the Development of the Nuclear- Active Components in Extensive Atmospheric Showers SOV/56-36-4-39/70

There are 2 figures and 11 references, 9 of which are Soviet.

ASSOCIATION: Institut yadernoy fiziki Moskovskogo gosudarstvennogo universiteta (Institute of Nuclear Physics of Moscow State University)

SUBMITTED: October 16, 1958

Card 3/3

VERNOV, S. N.

"Radiation Studies in Outer Space"
S. N. Vernov, A. E. Chadakov

The present paper contains the results of measurements carried out on Sputnik IIand Sputnik III (Soviet artificial earth satellites) and the Soviet cosmic rocket.

I. Measurements of the number of charged particles by means of two gas-discharge counters on Sputnik II showed the following: (1)

1. In the eastern hemisphere (latitudes 30° - 60°) up to 700 km. altitude the increase in the number of particles with altitude is slight and is determined by the diminishing geometric shadow of the earth and the decreasing lower limit of energy of cosmic-ray particles.

2. At latitudes above 60°, cases were observed of a considerable increase in intensity. The biggest increase (exceeding 50%) was observed on November 7, 1957 between 4 hr. 36 min. and 4 hr. 49 min. Moscow Time.

The absence of any increase in cosmic-ray intensity at the earth's surface at the same time shows that this phenomenon must be due to low-energy particles.

report presented at the International Cosmic Ray Conference, Moscow, 6-11 July 1959.

VERNOV S. N.

"The composition of Terrestrial Corpuscular Radiation and possible Mechanisms of its origin"

S. N. Vernov, A. E. Chudakov, A. I. Lebedinsky, I. P. Ivanenko

Investigations conducted during the flights of the Soviet earth satellites and the cosmic rocket have yielded the following data on the composition of "terrestrial corpuscular radiation", that is, particles revolving about the earth:

1. In the outer zone (1), the overwhelming majority of particles are electrons of energy 20 to 100 kev. If we represent the energy spectrum of these electrons in the reigion of maximum radiation in the form: N (E) 1/E , then 5. Extrapolation of such a soft spectrum into the region of lower energies shows that at E=5 to 10 kev, the total density of electron energy would exceed the energy density of the magnetic field H^2 /. 8 . For this reason, the electron spectrum in the region of low energies (several kilovalts) should either have a maximum or at least should be small at least in this region. The number of electrons of relatively high energies (5×10^6 ev) is negligibly small as compared with the number of electrons in the 20-100 Kev range. The overall energy released in the crystal of the scintillation counter from photons due to the bremsstrahlung of electrons is from two to three orders of magnitude in excess of the energy released by all high energy particles that produce an energy release in the crystal of over 4.5×10^6 ev per particle. The total energy of all electrons in the outer zone is approximately equal to the energy released in aurorae during somewhat over one week.

report presented at the International Cosmic Ray Conference, Moscow, 6-11 July 1959

VERNOV, S. N.

"MEASUREMENT OF COSMIC RAY VARIATION IN THE STRATOSPHERE"
S. N. Vernov, B. E. Samosudov, V. F. Tulinov, A. N. Charakhchian and T. N. Charakhchian

Beginning with July 1, 1957 (when the IGY programme began) regular measurements have been made of cosmic ray intensity in the stratosphere at geomagnetic latitudes of 51°N and 64°N, while since March 1958 similar measurements have been taken also at geomagnetic latitude of 41°N. The measurements are made with a single G-M counter. During this period 840 stratosphere observations were made.

1. The data gathered have helped to establish the existence of a 27-day variation of cosmic rays in the stratosphere. The shape of the averaged wave is close to sinusoidal while the period is 27 or 28 days. The wave amplitude, however, changes more than 5-fold in the observed intervals. The obtained values for the amplitude of the 27-day variation in the stratosphere are 8 to 10-fold that of similar data on the Earth.

2. The existence in the stratosphere of long periodical variations of cosmic rays of extra-terrestrial origin has been discovered.

3. Values have been obtained for the cosmic ray latitude effect between latutudes of 64°N, 51°N and 41°N. It has been ascertained that the latitude effect between 64°n and 51°N undergoes substantial changes with time. The latitude effect between these latitudes in the maximum of the intensity curve amounts on the average to several per cent, and goes up abruptly with increase in altitude of observation reaching 15-20% at an altitude of approximately 30 km. Several cases of abnormal increase in cosmic ray intensity in the stratosphere at the latutude of 64°N have been discovered.

Vernov, S. N. (continued)

cosmic ray intensity in the stratosphere at the latitude of 64°N have been discovered.

4. A correlation between 27-day variations of cosmic retiation and the floccula on the Sun, and a correlation between the long period cosmic ray variation and Sun spots has been established.

Report presented at the International Cosmic Ray Conference, Moscow, 6-11 July 1959

VERNOV S.

PHASE I BOOK EXPLOITATION SOV/5174

Pravda, Moscow.

Vtoroy Sovetskiy kosmicheskiy korabl'; materialy, opublikovannyye v gazete "Pravda" (The Second Soviet Cosmic Ship; Materials Published in the Newspaper "Pravda") Moscow, 1960. 198 p. 50,000 copies printed.

Resp. for this Publication: V. Reut and V. Smirnov; Tech. Ed.: V. Yagodkina.

PURPOSE: This book is intended for the general reader.

COVERAGE: The book is a compilation of articles which appeared in the newspaper Pravda after the launching, orbiting, and recovery of the capsule of the Soviet 4,600 kg spaceship on August 19, 1960. The articles give some details of scientific research undertaken in this flight in the fields of biology, cytology, genetics, cosmic radiation, solar radiation, ultraviolet radiation, and radiation levels. A description and three photos of the capsule are given. No personalities are mentioned. There are no references.

14

VERNOV, S.N.; CHUDAKOV, A.Ye.; VAKULOV,P.V.; LOGACHEV, Yu.I.; Nikolayev, A.G.
Associate Member, Academy of Science, USSR.

"Radiation Measurements During the Flight of the Second Soviet Space Rocket."

report presented at the First Intl Space Symposium, Nice, France, Jan 1960. National Academy of Sciences of the USSR, MOscow.'

VERNOV, S.N. and CHUDAKOV, A.Ye.

"Terrestial Corpuscular Radiation and Cosmic Rays."

report presented at the 1st Intl Space Symposium, Nice, France, January, 1960.
Academy of Sciences, Moscow, USSR.

VERNOV, S. N.

"The Exploration of Outer Space."

report presented at the XI International Astronautical Congress, Stockholm, Sweden, 15-20 August 1960

VERNOV, S.N.

pp. 2,3

SOV/4413

PHASE I BOOK EXPLOITATION

International Cosmic Ray Conference. Moscow, 1959.

Proceedings. v. III. Moscow, 1960. 253 p. Errata slip inserted. No. of copies printed not given.

Sponsoring Agency: International Union of Pure and Applied Physics. Cosmic Ray Commission.

Ed.: S. I. Syrovatskiy, Editorial Board: G. B. Zhdanov (Ed.-in-Chief), I. P. Ivanenko (Assistant Ed.-in-Chief), N. M. Gerasimova, A. I. Nikishov, V. I. Zatsepin, B. A. Khrenov, L. I. Dorman, V. F. Tulinov, S. I. Syrovatskiy, V. M. Fedorov, Yu. N. Vavilov, and A. T. Abrosimov.

PURPOSE: This book is intended for physicists, astronomers and other scientists concerned with the earth's radiation belts and cosmic ray research.

COVERAGE: This is Volume 3 of a 4-volume work containing the proceedings of the Moscow Cosmic Ray Conference held July 6-11, 1959. This volume contains 40 reports on the earth's radiation belts and primary cosmic radiation. The

Card ~~1/8~~

reports delivered by Soviet scientists are abstracted below. References accompany individual reports.

TABLE OF CONTENTS:

varied with increase in rocket distance from the Earth is compared with the corpuscular radiation intensity values obtained on the cosmic rocket and Pioneer III. The comparison shows that the observed changes in the Earth's magnetic field are related to the outer corpuscular region, and that they might be due to the superposition of the magnetic field of the corpuscular zone on the magnetic field of the Earth.

7. Vernov, S.N., A.E. Chudakov, A.I. Lebedinsky (Lebedinskiy), and I. P. Ivanenko. Composition of the Earth's Corpuscular Radiation and Possible Mechanisms of Its Origination 46-49

This paper presents data on the composition of the Earth's corpuscular radiation obtained by means of the Soviet sputniks and the cosmic rocket. The overwhelming majority of particles in the external zone, limited by magnetic lines of force crossing the Earth's surface at geomagnetic latitudes of 55° and 65°, are electrons of 20-100 Kev. Protons of approximately 100 Mev were discovered in the internal zone, limited by

magnetic lines of force crossing the Earth's surface at geomagnetic latitudes of 30-40°. Among the possible mechanisms of origination of the Earth's corpuscular radiation is injection into the Earth's magnetic field of electrons and protons, produced by the decay of neutrons emitted by the Earth's atmosphere as a result of cosmic ray irradiation.

9. Krassovsky (Krasovskiy), V.I., I.S. Shklovsky (Shklovskiy), G. I. Galperin, and E.M. Svetlitsky (Svetlitskiy). On Fast Corpuscles of the Upper Atmosphere 59-63

This paper presents experimental data on fast corpuscles of the upper atmosphere and gives a detailed description of the equipment used in the experiment.

11. Dorman, L.I. On the Problem of the Nature of Soft Radiation in the Upper Atmosphere 74-80

This paper summarizes the available data on bursts of soft radiation in the atmosphere and investigates the nature of the bursts in relation to processes on the sun, in corpuscular streams, and in the interplanetary medium. It also investigates the nature of these bursts in relation to the properties of the Earth's belts of radiation.

12. Askar'yan G. A. On the Nature of the External Radiation Belt of the Earth 81-82

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S/020/60/130/03/009/065
B014/B014

AUTHORS: Vernov, S. N., Corresponding ~~Member of the~~ AS USSR, Chudakov, A. Ye., Vakulov, P. V., Logachev, Yu. I., Nikolayev, A. G.

TITLE: Radiation Measurement During the Flight of the Second Cosmic Rocket

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol 130, Nr 3, pp 517 - 520 (USSR)

ABSTRACT: The equipment of the interplanetary rocket launched on September 12, 1959 was designed for measuring the outer radiation-belt of the Earth, for recording cosmic radiation on its flight from the Earth to the Moon and a potential radiation belt of the Moon. The individual parts of the apparatus, which consisted of six gas-discharge and four scintillation counters, are described in detail. Furthermore, this paper contains results of the first evaluation of data obtained for the range of from 9,000 to 120,000 km away from the center of the Earth and in the neighborhood of the Moon. Figure 1 illustrates the trajectories of the first and second interplanetary rockets referred to the terrestrial magnetic field. Ionization measure-

Card 1/3

Radiation Measurement During the Flight of the Second Cosmic Rocket

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ments are also graphically represented in figure 1. It is noted that the shift of the ionization maximum between the two measurements was not caused by the slight difference of the trajectories of the two rockets. The radiation belt is most probably deformed by streams of solar corpuscles. This assumption seems to be confirmed by a comparison with the results of measurements performed by the American rocket Pioneer III. The energy-flux density of electrons of more than 5 Mev or of protons of more than 30 Mev is said to be 1 particle/cm^2.sec. Furthermore, a radiation was detected which consisted of electrons having an energy of the order of 10^6 ev, or of protons of an energy of about 10 Mev. The first possibility is considered to be more probable. This electron flux is said to be 5.10^5 particles/cm^2.sec. The existence of electron fluxes having an energy of between 20 and 50 kev (flux: 10^{10} particles/cm^2.sec), which had already been detected by the first intercontinental rocket, were proven again. Thus, two essential groups of particle fluxes were found: electrons

Card 2/3

67908

Radiation Measurement During the Flight of the Second Cosmic Rocket

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of about 20 kev and 10^6 ev electrons. The energy of the first group is close to the mean energy of the solar corpuscular radiation and allows to assume the existence of a thermodynamic equilibrium between protons and electrons on their penetration into the terrestrial magnetic field. It is pointed out that the electron momenta of the second group are close to the proton momenta of corpuscular radiation and to the momenta of the electrons arising from the decay of the reflected neutrons. The existence of a lunar radiation belt could not be proven. Constant radiation intensity was measured at a distance of 70,000 km from the Earth. There are 2 figures, 1 table, and 2 references, 1 of which is Soviet.

SUBMITTED: November 20, 1959

Card 3/3

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S/020/60/136/002/013/034
B019/B056

9.9130 (1041, 1046, 1060)

AUTHORS: Varnov, S. N., Corresponding Member of the AS USSR, Chudakov, A. Ye., Vakulov, P. V., Gorchakov, Ye. V., Logachev, Yu. I., and Nikolayev, A. G.

TITLE: Radiation Measurements During the Flight of the Third Cosmic Rocket

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol. 136, No. 2, pp. 322-324

TEXT: The third cosmic rocket launched on October 4, 1959 contained a scintillation counter and three gas discharge counters. All gas discharge counters had a wall strength of 50 mg/cm^2 steel sheets and were, in addition, surrounded by several shields. Counter I had a shield made from 3 mm lead + 1 mm aluminum with a counter window of 0.28 cm^2, which was closed by a 0.2 mm thick aluminum sheet. Counter II had the same shield, but without counter window, and counter III was in an aluminum container made from 2.5 mm thick aluminum. The scintillation counter recorded the ionization of the crystal (NaI) and the counting rate. Preliminary results of evaluation of the instrument readings are given from the time from

Card 1/2

89610

Radiation Measurements During the Flight of the Third Cosmic Rocket

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B019/B056

October 4, 1959, to October 18, 1959. The trajectory of the rocket was in practical agreement with that of the first and second cosmic rocket. From a comparison of the readings of the various counters, the authors conclude that the intensities of the particles recorded by the instruments depend on the absorption in the container walls. Measurements in the interplanetary space showed that the cosmic radiation on the boundary of the terrestrial magnetic field is very strong; only individual small fluctuations were recorded. Finally, the agreement existing between the recorded intensities and those of a monitor are dealt with. From these considerations the authors draw the conclusion that the weak variations in the time from October 4 to October 18 are in connection with the variations of the magnetic fields in the solar system and the interactions among the latter are connected with cosmic radiations. There are 1 figure, 1 table, and 3 Soviet references.

SUBMITTED: October 26, 1960

Card 2/2

VERNOV, S.N.; CHUDAKOV, A.Ye.; VAKULOV, P.V.; LOGACHEV, Yu.I.; NIKOLAYEV, A.G.

Measurement of radiation during the flight of the second cosmic rocket. Isk.sput.Zem. no.5:24-29 '60.
(MIRA 13:5)

(Lunar probes) (Radiation--Measurement)

66010

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3.2000

AUTHORS: Vernov, S. N., Chudakov, A. Ye. S/053/60/070/04/002/011
B006/B011

TITLE: Investigations of Cosmic Rays and Terrestrial Corpuscular Radiation in the Flights of Rockets and Sputniks

PERIODICAL: Uspekhi fizicheskikh nauk, 1960, Vol 70, Nr 4, pp 585-619 (USSR)

TEXT: The present article offers a survey of methods and results obtained from the investigation of corpuscular radiation in the space round the earth by means of space rockets and artificial satellites. Chapter 1: equipment (scintillation counter, gas counter, photomultiplier). Chapter 2: the outer zone of the terrestrial corpuscular radiation belt (position of this zone relative to the earth, investigation of intensity fluctuations according to the ionization effect). Chapter 3: the inner zone of the high intensity of terrestrial corpuscular radiation (position of the inner zone relative to the earth, nature and energy of the particles in the inner zone, constancy of intensity). Chapter 4: radiations outside the magnetic field of the earth (Table). Chapter 5: analysis of data obtained and possible hypotheses concerning the origin of terrestrial corpuscular radiation. Summarizingly, the following is stated: 1) The earth is surrounded by two spatially separate zones of high-intensive radiation. 2) The outer zone extends in the equatorial plane from about 20,000 to 60,000 km out from the earth center and is delimited by the lines of force of the geomagnetic field. In geomagnetic latitudes of 55 - 70°, this zone

Card 1/4

Investigations of Cosmic Rays and Terrestrial Corpuscular Radiation in the Flights of Rockets and Sputniks

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is observed at relatively low altitudes (300-1500 km). The intensity changes with time are considerable; in the flight of the first Russian cosmic rocket, the radiation maximum was recorded on January 1, 1959 at a distance of 26,000 km from the earth center on a line of force cutting the earth surface on the 63rd degree of latitude. In the flight of the second Russian cosmic rocket, this maximum was recorded at a distance of 17,000 km on the 69° line of force. 3) The particles occurring in this zone are electrons of two energy groups. The electrons of the first group have some ten kev. The maximum flux of electrons with energies greater than 20 kev amounts to $10^9 cm^{-2} sec^{-1} steradian^{-1}$. Electrons of the second group have energies of the order of 10^6 ev and exhibit a maximum flux of $10^5 cm^{-2} sec^{-1} steradian^{-1}$. 4) The inner zone begins on the equatorial plane at an altitude of 600 km on the Western hemisphere and extends up to distances equalling the terrestrial radius; it is delimited by a line of force on 35° latitude. The radiation intensity in this zone remains constant within about 15% in one month. 5) The particles occurring in this zone are protons of about 10^8 ev, their flux attains $10^2 cm^{-2} sec^{-1} steradian^{-1}$. On the edge of the zone in the geomagnetic interval of 35-40° latitude, a low-energy radiation (electrons of less than 10^6 ev) is

4

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Investigations of Cosmic Rays and Terrestrial Corpuscular Radiation in the Flights of Rockets and Sputniks

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ascertained. 6) Between the two zones, in the interval of the geomagnetic latitudes of 40-55°, there is a region in which no higher radiation intensity is detected. Provided that measurements are accurate, it may be assumed that in this region, at an altitude of 300-700 km, the flux of electrons with more than 100 kev amounts to less than one-thousandth of the flux at the boundary of the outer zone. The same ratio compared with the one at the boundary of the inner zone holds for the flux of protons with more than 10^8ev. 7) The particle radiation outside the magnetic field of the earth consists of protons and other nuclei (flux 2 particles/cm^2.sec). The photon flux in the interplanetary space is less than 0.1 photon/cm^2.sec ($h\nu > 450$ kev) and <3photons/cm^2.sec ($h\nu > 45$ kev), respectively. 8) It is concluded from a comparison of experimental data with theoretical considerations that the high-energy protons are the result of a decay of neutrons emitted from the earth atmosphere. The radiation intensity in the center of the inner zone at low altitudes is determined by the ionization losses of the protons in the upper atmospheric layers. In geomagnetic latitudes of more than 30° and at larger altitudes of the equatorial plane intensity drops more rapidly due to the incompleteness of the magnetic trap. This incompleteness is independent of the particle energy, and it is therefore improbable for it to be related with the nonconservation of the

Card 3/4

4

magnetic moment of the particles. Ye. V. Gorchakov, S. Sh. Dolginov, G. I. Golyshev, V. G. Kort, A. I. Lebedinskiy, and I. P. Ivanenko are mentioned. There are 18 figures, 1 table, and 17 references, 14 of which are Soviet.

4

VERNOV, S.N., otv. red.; DORMAN, L.I., kand. fiz.-mat. nauk, otv. red.; KURYKOVA, M.F., red.; GUS'KOVA, O.M., tekhn. red.

[Articles] Sbornik statei. Moskva, Izd-vo AN SSSR.
No.1.[Variations of cosmic rays below ground, at sea level, and in the stratosphere] Variatsii kosmicheskikh luchei pod zemlei, na urovne moria i v stratosfere. 1959. 56 p.
No.2.[Variations of cosmic rays and solar corpuscular streams] Variatsii kosmicheskikh luchei i solnechnye korpuskuliarnye potoki. 1960. 143 p.
(MIRA 16:11)

1. Akademiya nauk SSSSR. Mezhduvedomstvennyy geofizicheskiy komitet. VII razdel programmy MGG: Kosmicheskiye luchi. 2.Chlen-korrespondent AN SSSR (for Vernov).

(Cosmic rays)

S/030/60/000/008/002/013
B021/B054

AUTHOR: Vernov, S. N., Corresponding Member of the Academy of Sciences USSR

TITLE: Cosmic Rays and Cosmic Space

PERIODICAL: Vestnik Akademii nauk SSSR, 1960, No. 8, pp. 10-26

TEXT: This is a report delivered by the author at the Plenary Meeting of the Akademiya nauk SSSR (Academy of Sciences USSR) on June 10, 1960. Experiments made by Academician D. V. Skobel'tsyn showed that cosmic rays consist of high-energy particles. An investigation of these rays permits two essential problems to be solved: first, the determination of the properties of the cosmic space where they are formed, and second, the use of cosmic rays for the bombardment of atomic nuclei. The author in his report deals with the former problem, but he briefly mentions experiments which showed the presence of particles of energies of up to a billion billions of electron volts in cosmic rays. He also briefly describes the plant of the Moskovskiy gosudarstvennyy universitet (MGU) (Moscow State University)(Fig. 1) for the investigation of superhigh-

Card 1/4

energy particles, which was designed by the author together with G. B. Khristiansen and G. T. Zatsepin. Fig. 2 shows the distribution of particles in the diffusion chamber, Fig. 3 a schematic cross section of the MGU plant. It may be assumed at present that superhigh-energy particles are formed outside the boundaries of our galaxy. Further, the author investigates the cosmic space in close vicinity of the earth. Investigations by means of artificial satellites and space rockets showed that the earth is surrounded by two radiation zones, the internal and the external one, the intensity of their radiations being very high. This circumstance has to be considered in the construction of space ships. Fig. 4 shows diagrams of the measuring apparatus of earth satellites. The investigations were made by the author together with A. Ye. Chudakov, Yu. I. Logachev, P. V. Vakulov, Ye. V. Gorchakov, and A. G. Nikolayev. An ФЭУ (FEU) photoelectric multiplier was used in the scintillation counter. Fig. 5 shows the measurement results of the second earth satellite on November 7, 1957. Fig. 6 shows a sample of the recordings made by the instruments of the third earth satellite. Fig. 7 shows the diagram of a large part of the northern hemisphere. The projection of the flight path of a particle on the plane of the meridian

is shown in Fig. 8. Investigations proved that radiation intensity increases with the distance from the earth along the line of force, and that the particles of the radiation zones in the magnetic field of the earth oscillate from one hemisphere into the other. Therefore, it may be assumed that the magnetic field of the earth represents a trap for the particles. The flight paths of the Soviet space rockets and the change in radiation intensity during the flight are shown in Figs. 9-12. N. V. Pushkov and Sh. Sh. Dolginov discovered anomalies of the magnetic field of the earth during the flight of the first Soviet space rocket. Fig. 13 shows a sample of the recordings of radio signals made by the third Soviet earth satellite. The measurements showed that electrons of relatively low energy are present in the external radiation zone of the earth, and particles of more than 10,000,000 ev in the internal zone. Fig. 14 shows a general picture of the distribution of radiation zones around the earth. As to the origin of the radiation zones of the earth, the hypothesis may be set up that the magnetic field of the earth represents a trap for the particles in which they may stay for a very long while. The origin of the external radiation zone of the earth is sought in the corpuscular radiations of the sun. The flight around the moon

showed that the moon has no magnetic field. It is assumed that in the cosmic space there are giant reservoirs of particles moving about, as had been detected by A. N. Charakhch'yan by means of special radiosondes. These experiments showed that the sun emits cosmic rays once a month, on an average. During that time, their intensity is so high that man cannot stay in the interplanetary space without protective equipment. As yet, the explosion processes of the sun cannot be predicted. There are 14 figures.

VERNOV, S.N.

About the "corona" of the earth. Znan.sila 35 no.3:37-39 Mr '60. (MIRA 13:6)

1. Chlen-korrespondent AN SSSR.
(Particles (Nuclear physics) (Atmosphere, Upper)

VERNOV, S.N.; GORYUNOV, N.N.; DMITRIYEV, V.A.: KULIKOV,G.V.; NECHIN, Yu.A.; KHRISTIANSEN, G.B.

Function of the spatial distribution of a flux of charged particles in an individual extensive air shower. Zhur. eksp. i teor. fiz. 38 no.1:297-298 Jan '60. (MIRA 14:9)

1. Institut yadernoy fiziki Moskovskogo gosudarstvennogo universiteta.

(Cosmic rays)

S/056/60/039/002/042/044
B006/B070

AUTHORS: Vernov, S. N., Ivanenko, I. P., Kulikov, G. V., Khristiansen, G. B.

TITLE: The Nature of the Particle Beams in the Core of an Extensive Air Shower

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 2(8), pp. 509 - 512

TEXT: In an earlier paper (Ref. 1) the authors communicated their investigations of a shower core by means of diffusion chamber. They found that narrow beams consisting of 4-15 particles appear, and the beam trajectories are collinear. These particle beams are, either, cores of electron-photon avalanches released from π^0-mesons, or groups of high-energy muons. Which of these alternatives is correct, is now investigated. In the present paper, the authors show that the latter is much more probable. The first assumption is discussed in detail, and the experiment and its results are analyzed from this stand-point. The observed number of particles in the beam can only be released by primary particles whose

Card 1/3

energy $E_o \geq 10^{12}$ ev. The energy spectrum of electrons and photons in the avalanche at a depth of 2t-units had the following form (N - number of particles released by particles with $E_o = 10^{12}$ ev):

E	10^8	10^9	10^{10}	10^{11}
$N_{el}(>E)$	5.5	4.0	2.5	0.5
$N_{phot}(>E)$	10	8.0	4.0	0.8

For their experiments, the authors used a plate of lead glass (type ТФ-1 (TF-1)) with high lead content. This plate covered one half of the diffusion chamber. 850 hours of measurement were made in the open chamber and 440 hours in the closed one. The actual number of particles observed in the showers is much smaller than that which would be expected if the first assumption on the nature of the collinear beam were true. Experiments performed with diffusion chamber, arranged above two rows of ionization chambers, gave similar results. The second assumption, that the observed beam consists of μ-mesons, is then briefly discussed. For